

**CULEX (CULEX) PIPIENS LINNAEUS (DIPTERA: CULICIDAE):
CONCEPTS, TYPE DESIGNATIONS, AND DESCRIPTION¹**

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Abstract.—The history of the concept of *Culex pipiens* Linnaeus is reviewed. An illustration of a syntype published by Réaumur is designated as the lectotype of *pipiens*. A lectotype is also designated for *Culex bifurcatus* Linnaeus, which is stabilized as a synonym of *pipiens*. A neotype for *pipiens* is designated in place of the non-extant lectotype-specimen. The adult, pupal, and larval stages of the neotype are described and illustrated. Sexual differences are described and illustrated for the alloneotype. A description of diagnostic and variable characters is provided for each life stage of the species.

The present system of naming organisms originated with the work of Carolus Linnaeus, and the 10th edition of his *Systema Naturae* (1758) is the designated starting point of zoological nomenclature. In that volume, Linnaeus described six species of *Culex*, the first being *Culex pipiens*. The family Culicidae (Stephens, 1829) is based on the genus *Culex* for which *pipiens* is the type-species (Latreille, 1810). Of the other species described in 1758, only *Culex bifurcatus* remains in Culicidae, but has been treated as a synonym of *pipiens* (Martini, 1922; Edwards, 1932; Stone et al., 1959; Knight and Stone, 1977).

The Linnaean Collection is now the property of the Linnean Society of London. It includes two original mosquito specimens located in Diptera box 22 (transferred from old box 195). One of the specimens is a female bearing Linnaean labels (sense of Day and Fitton, 1978) inscribed "Culex." and "l. pipiens" (Fig. 1A-D). This specimen represents a species of *Aedes* (*Ochlerotatus*), but it is badly damaged and unidentifiable to species. The other specimen is a male of the *maculipennis* complex of *Anopheles* (White, 1978), and it bears a Linnaean label inscribed "2 bifurcatus." (Fig. 1E, F). These findings revealed the need to stabilize the Linnaean mosquito nomenclature relevant to the western Palearctic fauna (Dahl and White, 1977) and the taxonomy of the *pipiens* complex under investigation by the senior author as part of a revision of the *Culex* (*Culex*) of northern Africa and south-western Asia.

¹ The opinions or assertions contained herein are the private views of the authors and are not to be construed as official or as reflecting the views of the supporting agencies.

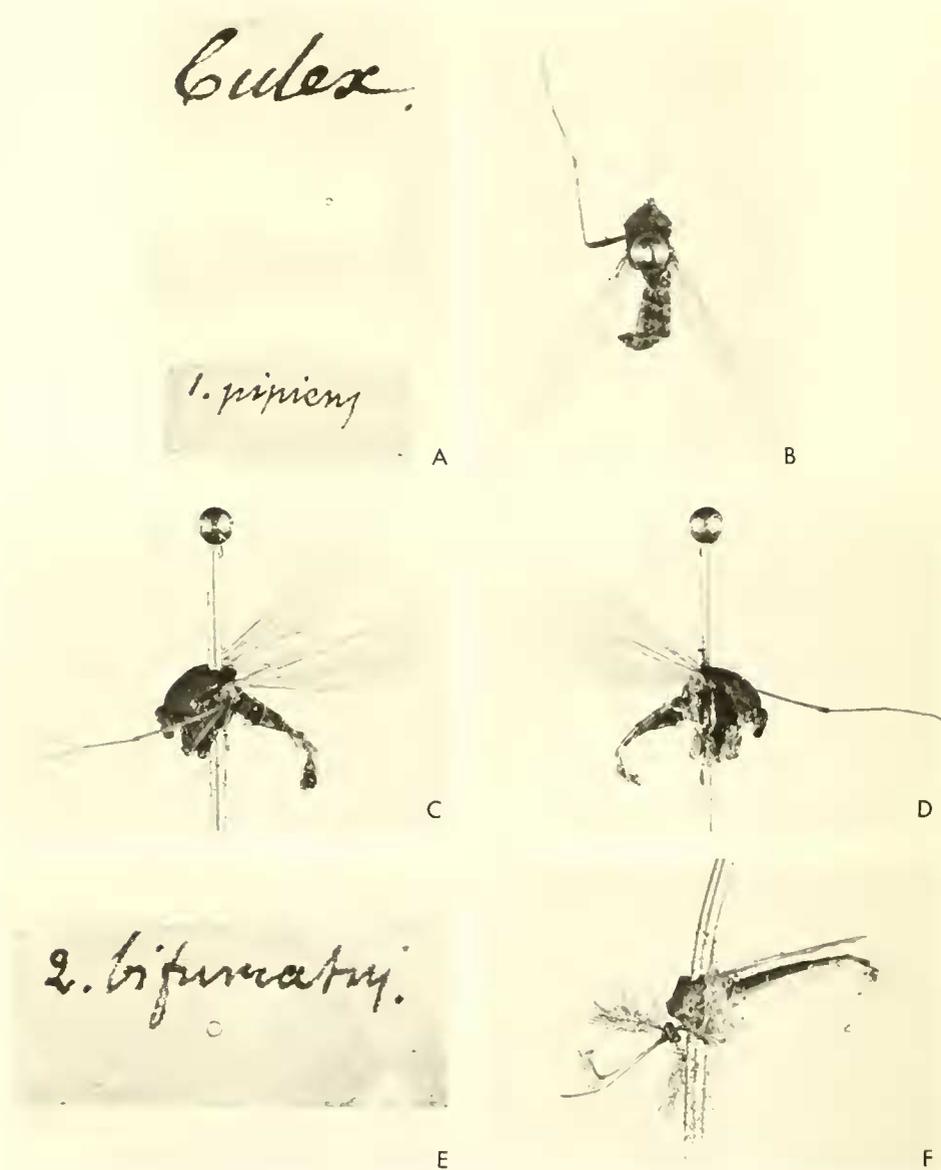


Fig. 1. A-D, Linnaean labels (A) accompanying the original female specimen (B-D) of *Culex pipiens* Linnaeus in the Linnaean Collection. The specimen actually belongs to a species of *Aedes* (*Ochlerotatus*). E, F, Linnaean label (E) accompanying the original male specimen (F) of *Culex bifurcatus* Linnaeus in the Linnaean Collection. The specimen actually belongs to a species of the *maculipennis* complex of *Anopheles*. B, dorsal aspect; C, F, left sides; D, right side.

There is no reason to doubt the authenticity of the mosquito specimens in the Linnaean Collection. Where Linnaean species are represented by a single specimen which bears a handwritten label with the specific name and the number of the species in the 10th edition of *Systema Naturae*, the specimen is likely to be a Linnaean original (Lindroth, 1957; Day and Fitton, 1978; Robinson and Nielsen,

1983). The specimen labelled *pipiens* also bears the generic name of *Culex* because it represents the first species which Linnaeus described for the genus.

The taxonomic units conceived by Linnaeus were based on conspicuous morphological characteristics, not phylogenetic interpretations. His concepts were much broader than ours. Accordingly, the genus *Culex*, as it was formalized in 1758, included species of Ceratopogonidae (*pulicaris*), Simuliidae (*reptans*; *equinus*) and Empididae (*sterocoreus*) in addition to Culicidae (Dyar and Knab, 1909; Knight, 1972). Regarding the Culicidae, it is obvious that Linnaeus discerned only two general kinds of mosquitoes, the twittering mosquito (*Culex pipiens*) and the mosquito with a forked beak (*Culex bifurcatus*). These concepts were published in the first edition of *Fauna Svecica* (Linnaeus, 1746, species numbers 1116 and 1115, respectively) before they appeared in the 10th edition of *Systema Naturae* along with their assigned specific names.

Reference made by Linnaeus (1746) to "*Culex ipse in sylvis, praesitem Lapponiae*" is evidence that he included forest *Aedes* in his concept of *pipiens*. On the other hand, Linnaeus cited illustrations in the works of Swammerdam (1737: pl. 31, Figs. 4–8; pl. 32, Figs. 1–5), Réaumur (1738: pls. 43, 44) and Joblot (1754: pl. 13, Figs. A–E, H, I, L) which unequivocally depict a species of *Culex* compatible with our modern concept of *pipiens* (see Réaumur's plates which are reproduced here in Figs. 2 and 3). Moreover, observations made by Linnaeus concerning "Hominibus & animalibus sono alarum & sanguinis suctu molestissimus" (1746) and "*Insectum pipiens, pungens*" (1758) imply that *pipiens* represented any culicine female known to him. Linnaeus (1758) recognized the ubiquity of these animals when he wrote "*Habitat in Europae aquis; copiosissima in Lapponia; etiam in America obvia.*" This statement is the source for what are regarded as the type-localities of *pipiens*.

Virtually all workers of the late 18th and early 19th centuries (notably: Linnaeus, 1761, 1767; Sulzer, 1761; Geoffroy, 1762; Scopoli, 1763; Schaeffer, 1766; De Geer, 1776; Fabricius, 1781, 1787, 1794, 1805; Schrank, 1781, 1803; Herbst, 1787; de Villers, 1789; Gmelin, 1790; Rossi, 1790; Olivier, 1791; Meigen, 1804; Latreille, 1809) used the name of *pipiens* in the sense of Linnaeus (1758). It was not until Meigen (1818) separated the genera of *Aedes* and *Anopheles* from *Culex* that the present concept of *pipiens* began to develop. This concept was founded on the descriptions and illustrations in the works cited by Linnaeus, particularly the detailed account of the immature stages given by Réaumur (1738) (see Figs. 2, 3). The exact identity of *pipiens* remained rather obscure until Dyar and Knab (1909) figured the male phallosome based on a comparison of specimens from Denmark, France, Hungary, and the United States. The current concept was fully realized when Martini (1925) distinguished and described *Culex torrentium*, a species previously confused with *pipiens* in Europe.

Incidentally, De Geer (1776) substituted the name of *Culex communis* for Linnaeus' concept of *pipiens*. This is evident from the synonyms De Geer lists under *communis*. Most important among these are *Culex pipiens* and the figures in Blankaart (1688), Swammerdam (1737), and Réaumur (1738) on which Linnaeus partially based his concept of this species. De Geer's two specimens of *communis* in the Naturhistoriska Riksmuseet, Stockholm, are actually species of *Culiseta*. This fact supports Linnaeus' broad concept of *pipiens* as including other culicine species. De Geer exchanged correspondence and specimens with Linnaeus

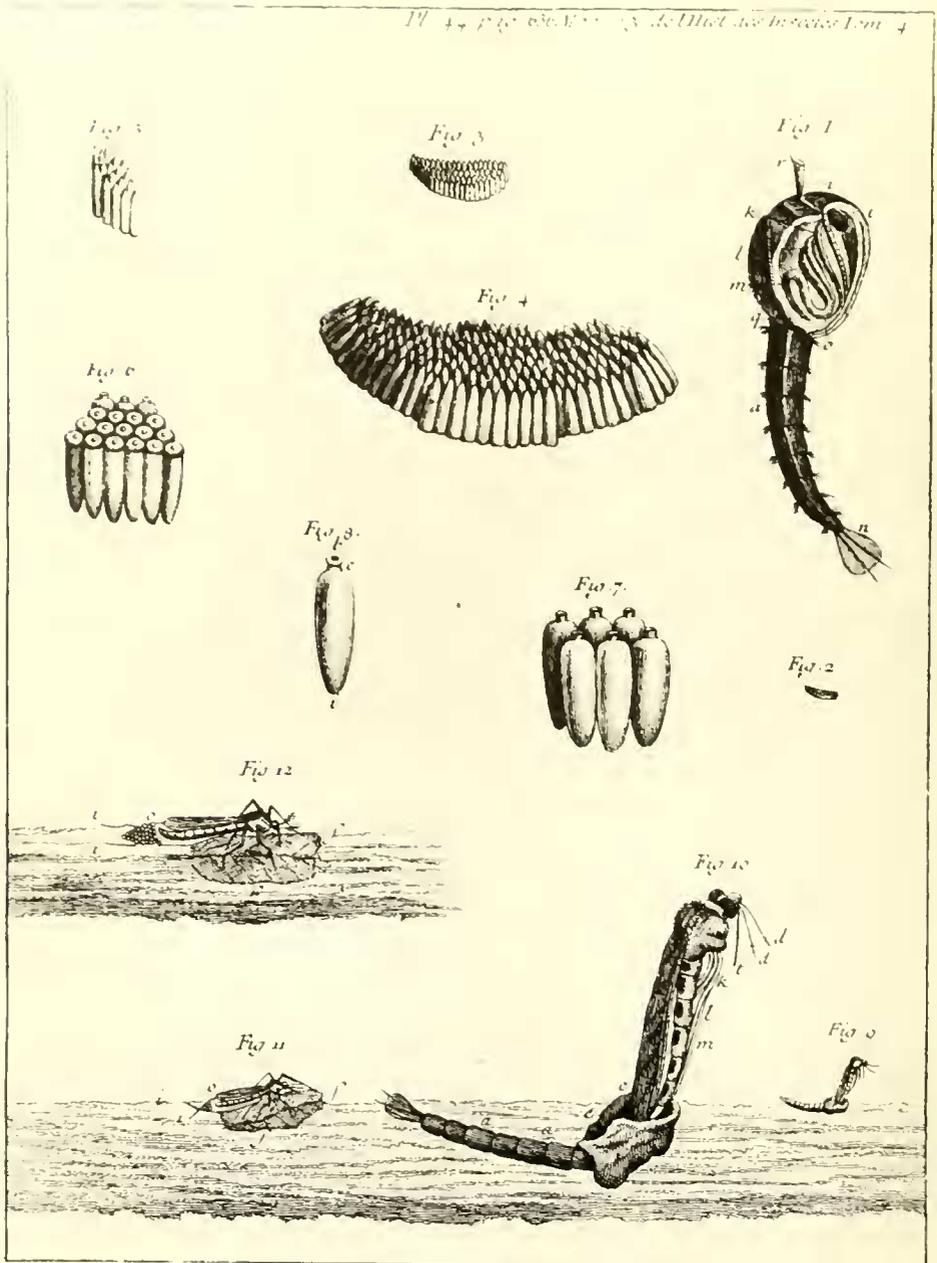


Fig. 2. Plate 44 of Réaumur (1738) on which Linnaeus (1758) partially based his concept of *Culex pipiens*. Notice that the eggs illustrated upside down bear a corolla ("col") characteristic of *Culex*.

who identified much of De Geer's material. Needless to say, *Culex communis* De Geer was treated as a synonym of *Culex pipiens* Linnaeus by most authors until Edwards (1921) revived the name for the species previously commonly referred to as *Aedes nemorosus* (Meigen). *Aedes communis* is now recognized as the nominotypical member of a sibling species complex (Ellis and Brust, 1973).

Culex pipiens is one of the most important mosquito species for reasons of its widespread abundance, biological characteristics, and taxonomic significance. Unfortunately, it belongs to a complex of species which represents one of the major outstanding problems in mosquito taxonomy. Basic to the resolution of this problem is the delimitation and fixation of the names of the taxa involved. The first step in this direction was taken by Belkin (1977) who established the priority of *Culex quinquefasciatus* Say over *Culex fatigans* Wiedemann and set the stage for Sirivanakarn and White (1978) to designate a neotype for *quinquefasciatus*. Recently, Harbach et al. (1984) designated a neotype to fix the identity of *Culex molestus* Forskål.

The need for a primary type-specimen for *Culex pipiens* is apparent. Obviously, acceptance of the venerable specimen in the Linnaean Collection as the "type" of *pipiens* (reasoning of Crosskey, 1974), or designation of this specimen as the lectotype (reasoning of Vane-Wright, 1975), would drastically upset the current concept of *pipiens* and catastrophically alter the accepted meaning of the genus *Culex*. Fortunately, the specimens portrayed in the published illustrations upon which Linnaeus founded his concept are valid syntypes of *pipiens* (Article 73b(i), *International Code of Zoological Nomenclature*, 1985). Accordingly, the larva illustrated by Réaumur (1738: pl. 43, Fig. 3) (see Fig. 3) is hereby designated lectotype of *Culex pipiens* Linnaeus. Unfortunately, Réaumur studied insects as natural history objects without preserving specimens for posterity, and the lectotype-specimen is non-extant (this does not invalidate the lectotype designation, see Article 74c of the *Code*). Furthermore, Réaumur's illustration of the lectotype does not show the characters which distinguish *pipiens* from *torrentium*. For these reasons, a neotype is designated below. It should be noted that the existence of a paralectotype (the Linnaean specimen in London) does not preclude the designation of a neotype (Article 75b(iii) of the *Code*).

The neotype designation satisfies all of the qualifying conditions of the *Code* except, perhaps, Article 75b(5) which requires that a neotype be collected as near as practicable to the original type-locality. As indicated above, the "original" type-locality of *pipiens* was very broad, comprising Europe, Lapland, and America (Linnaeus, 1758), but with the lectotype designation, the provenance of the type is restricted to France. However, the neotype selected below originated in Sweden. Thus, the neotype designation fixes a type-locality for *pipiens* which is not the same as that established by the lectotype. Nevertheless, we feel justified in selecting a neotype from elsewhere for the following reasons. First, emphasis was placed on obtaining specimens of the genus and species so well figured by Réaumur. Secondly, it seemed desirable to acquire material from a Swedish locality that could have been visited by Linnaeus. Finally, and most importantly, although material was available to us from France, none of it was individually reared and did not meet our high standards for type-material. A precedent for selecting a neotype from outside the original type-locality was established in the case of *Culex*

aegypti Linnaeus (Mattingly et al., 1962; International Commission for Zoological Nomenclature, 1964).

The case of *bifurcatus* can be dealt with in parallel with that of *pipiens*, although neotype designation is unnecessary. When Linnaeus described *bifurcatus*, he cited figures 1 and 2 of plate 40 in Réaumur (1738) (reproduced here in Fig. 4) which clearly illustrate a *Culex* male, presumably belonging to the same species whose immature stages are illustrated on the plates which Linnaeus cites as representing *pipiens*. Unfortunately, the relation of the sexes was unclear to Réaumur, and he referred to the male as a separate species based on the character of the maxillary palpi. Furthermore, Réaumur regarded the palpi as a forked beak, and this, of course, influenced Linnaeus when he named *bifurcatus*. With this in mind, it appears that Linnaeus' concept of *bifurcatus* included any mosquito with long palpi, i.e., anophelines and male culicines. In any case, the figures cited by Linnaeus eventually led Martini (1922), the first reviser, to synonymize *bifurcatus* with *pipiens*. To stabilize this synonymy, the male illustrated by Réaumur (1738: pl. 40, Fig. 2) (see Fig. 4) is hereby designated lectotype of *Culex bifurcatus* Linnaeus. This action has the advantage of not destabilizing current usage of the name for whichever Palearctic species of *Anopheles* is represented by the Linnaean specimen.

MATERIALS AND METHODS

Our original intention was to select a neotype for *pipiens* from specimens originating in Linnaeus' garden in Uppsala. To our disappointment, collections made there in the summer of 1983 contained only larvae of *Culex torrentium*. In August of the same year, two collections containing substantial numbers of larvae conforming to the prevailing concept of *pipiens* were made near Veberöd, Scania, Sweden. These were expeditiously shipped to Washington, DC, where the larvae were individually reared for study. A neotype (specific information is provided with the designation below) and an alloneotype were chosen from one of these collections. Seventy-eight adults (9 males and 6 females with pupal exuviae; 34 males and 29 females with larval and pupal exuviae) and 14 fourth-instar larvae comprised the collection containing the neotype and alloneotype. Additionally, 34 adults (9 males with pupal exuviae; 14 males and 11 females with larval and pupal exuviae) and 10 fourth-instar larvae were obtained from the second collection which was made in an old boat on the shore of Lake Krankesjö near the site where the neotype originated. The collections also yielded 392 specimens of *Culex torrentium*: some 67 males, 69 females, 136 pupal exuviae, 102 larval exuviae, and 18 fourth-instar larvae.

Detailed descriptions and illustrations of the adult, pupal, and larval stages of the neotype are provided. Characters which differ in the alloneotype are described, and some important adult sexual differences are illustrated. A description of diagnostic and variable characters for each life stage based on associated specimens is also included. Character measurements, setal counts, and setal branching counts were made on the neotype and alloneotype, and 10 specimens collected with them. The morphological terminology follows Harbach and Knight (1980), except that siphon indices were calculated using the basal width of the siphon rather than the width measured at midlength. Ratios of DV/D (Sundaraman, 1949) were determined using the method of Barr (1957).

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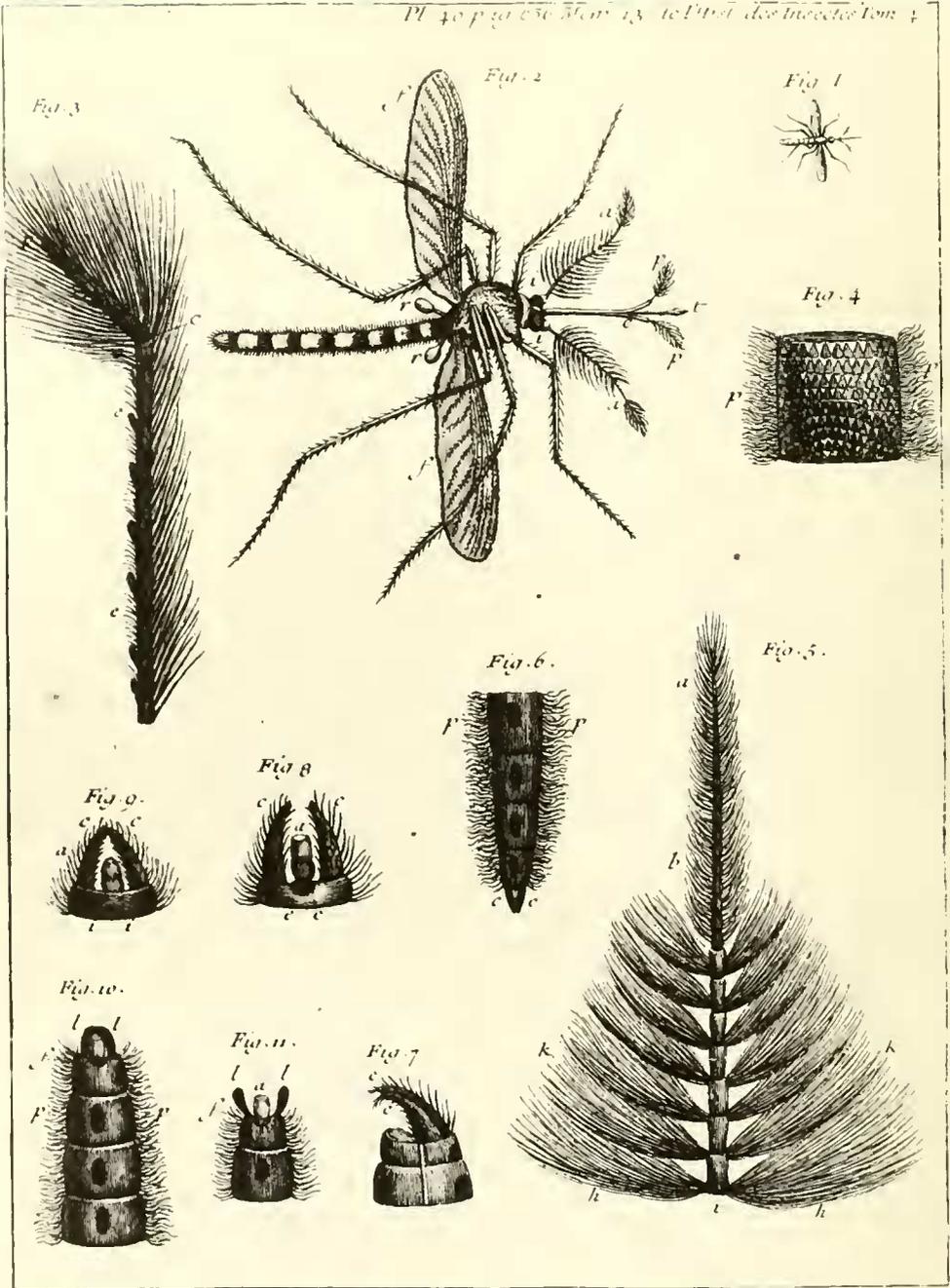


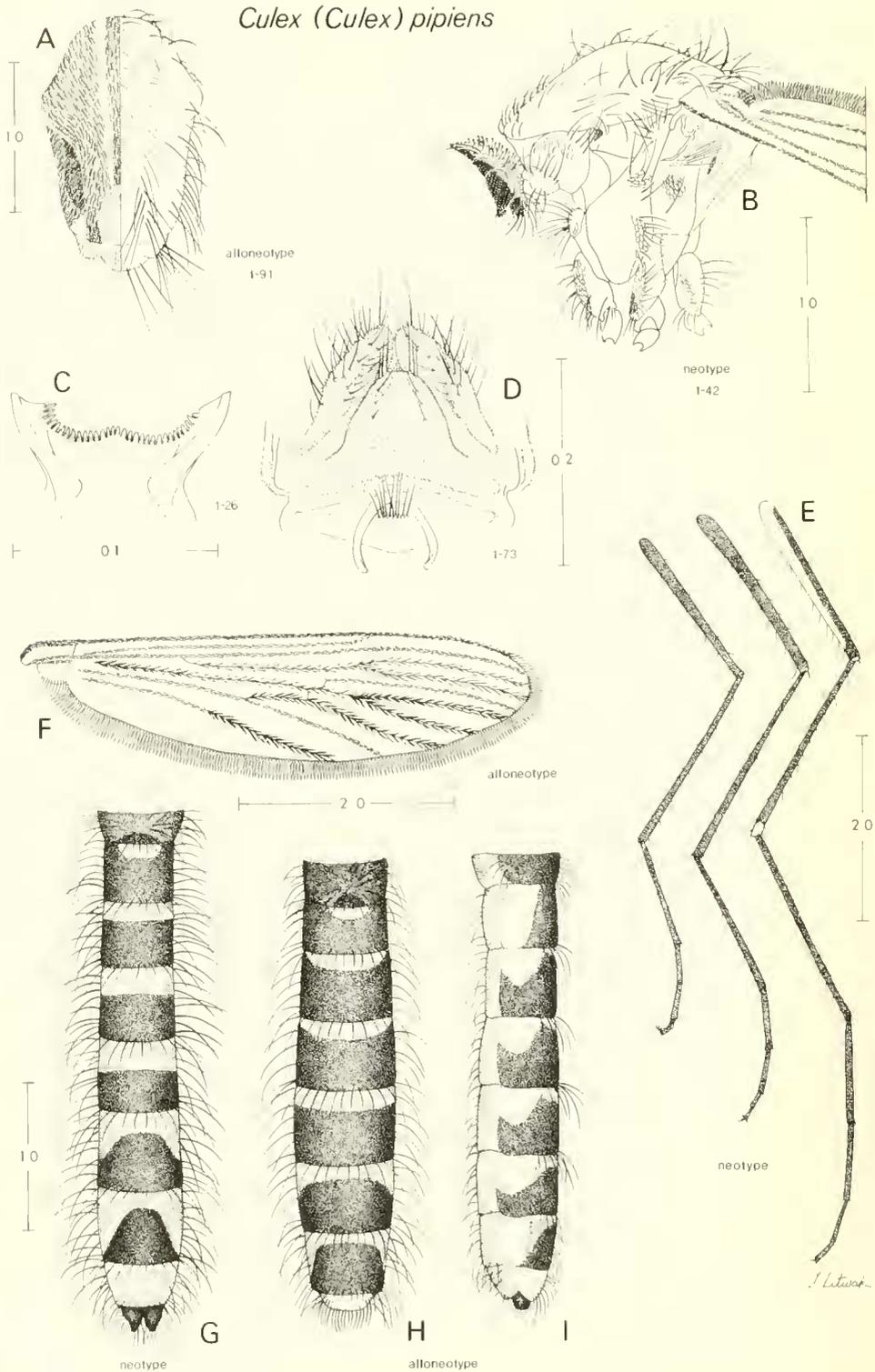
Fig. 4. Plate 40 of Réaumur (1738) showing figures 1 and 2 on which Linnaeus partially based his concept of *Culex bifurcatus*. "Fig. 2" illustrates the lectotype male.

Culex (Culex) pipiens Linnaeus

Neotype (hereby designated): ♂ (1-42) with associated larval and pupal exuviae and genitalia on slides, and with the following collection data: SWEDEN, Scania, Veberöd, Silvåkra farm, near Lake Krankesjö, open water reservoir (vessel), 15 m ASL, 23.8.1983, Coll. C. Dahl. Deposited in the National Museum of Natural History, Washington, DC, Type No. 101370.

Male (Neotype) (Fig. 5). A medium-sized mosquito closely resembling *Culex torrentium* Martini but without prealar scales and with different genitalia. Also closely resembling *Culex quinquefasciatus* Say and *Culex restuans* Theobald, but differing in the character of the scutal scaling, tergal banding, and genitalia. *Head*: Length of antennal flagellum 1.6 mm; flagellomeres 1-12 pale between whorls; flagellomeres 13 and 14 dark, combined length about 0.7 mm, approximately 0.45 of flagellum length; pedicel orange, black mesally. Proboscis mainly black-scaled, with ventral patch of white scales 0.3 to 0.7 from base; without ventral cluster of setae at false joint; length 2.2 mm, false joint 0.6 from base; labella dark. Length of maxillary palpus 2.9 mm, 1.3 of proboscis length, extending beyond tip of proboscis by length of palpomere 5; palpus mainly black-scaled, integument between palpomeres 2 and 3 pale; lateral surface of palpomere 3 with stripe of white scales 0.4 to 0.9 from base, stripe bordered ventrally by row of about 22 long black setae on distal 0.5 of palpomere, ventral surface devoid of scales and pale, with ventromesal row of about 18 small antroresely-curved setae; palpomere 4 with nearly complete narrow ventral stripe of white scales; palpomere 5 with small patch of white scales ventrally at base; lateral surfaces of palpomeres 4 and 5 with long black setae that are longest at base of 4 and become gradually shorter toward apex of 5. Forked scales of vertex rather short, mainly dark, some pale medially; falcate scales narrow, pale yellow, slightly paler laterally; lateral spatulate scales yellowish white. Ocular setae black, antroresely curved. Interocular space narrow, setae yellowish brown. *Thorax* (Fig. 5B): Pleural integument yellowish brown, darker anteriorly, faded posteriorly; scutal integument dark brown. Scutal scales fine, golden brown with slight reddish tint, somewhat finer on fossae and supraalar areas; integument and scales between supraalar and posterior dorso-central setae not noticeably darker; pale yellow scales on outer margins of supraalar and prescutellar areas. Scutal setae nearly black (many prescutellar setae missing). Scutellum with narrow pale yellow falcate scales; 5 large setae on each lateral lobe (1 missing on left lobe), 8 on median lobe (6 missing). Anteprotonum with 2 patches of narrow falcate scales, upper patch golden brown, scales of lower patch coarser and very pale yellow; setae mainly dark, pale ventrally. Postprotonum with golden-brown falcate scales, paler and slightly coarser posteriorly; with 5 setae on posterodorsal margin, longer and paler posteriorly. Pleural setae golden, numbers on left side as follows: 19 upper proepisternal in more or less double row, 10 prealar, 5 upper mesokatepisternal, 10 lower mesokatepisternal with uppermost seta very prominent, 7 upper mesepimeral, and 1 prominent lower mesepimeral. Pleural scales spatulate, few below upper proepisternal setae yellowish, others white and in patches as follows: patches on upper corner and lower posterior border of mesokatepisternum, anterior patch on mesepimeron at nearly same level as upper mesokatepisternal patch, and small patch before upper mesepimeral setae; without postspiracular and prealar scales. *Wing*: Length 3.4

Culex (Culex) pipiens



mm; cell R_2 2.9 of R_{2+3} ; subcosta intersects costa before furcation of R_{2+3} ; cell M_1 0.8 of cell R_2 ; scales entirely dark. Dorsal scaling: broad squame scales on costa, subcosta, R, R_1 , and CuA; relatively narrow squame scales on R_{4+5} , M_1 , M_2 , M_{3+4} , mCu, and proximally on 1A; linear plume scales on R_5 , R_{2+3} , R_2 , R_3 , M, M_{1+2} , and distally on 1A; remigium with 2 distinct rows of scales and 2 setae (3 on right wing) distally. Ventral scaling: squame scales on costa, subcosta, base of R_1 , R_5 , R_{2+3} , bases of R_2 and R_3 , M_{1+2} , and bases of M_1 and M_2 ; plume scales on other veins and parts of veins except CuA before mCu and proximal 0.5 of 1A which are devoid of scales. *Halter*: Entirely pale. *Legs* (Fig. 5E): Anterior surface of forecoxa mainly black-scaled, with small basal patch of yellowish scales, anterior surface also with many long, nearly black, ventrally-curved setae, apex with 4 setae on posterior margin, most proximal seta nearly perpendicular to surface, others project ventrally; midcoxa with midlateral longitudinal row of 4 long dark setae and 6 or 7 short pale setae, setae margined anteriorly by longitudinal patch of white spatulate scales, anterior surface with small patch of black scales and several ventrally-projecting setae at apex; posterolateral surface of hindcoxa with longitudinal row of 7 long golden setae becoming gradually shorter from base to apex, anterolateral surface with narrow longitudinal row of nearly colorless scales and 4 short ventrally-projecting setae at apex, mesal surface with 2 dark setae at apex. Ventral surfaces of trochanters with white spatulate scales; anteroventral surface of fore- and midtrochanters with some black spatulate scales. Apices of all femora with narrow dorsal border of yellowish scales; forefemur with anterior surface black-scaled, posterior surface white-scaled; midfemur like forefemur but black scales extending over dorsal surface toward apex; hindfemur mainly white-scaled, with complete anterodorsal stripe of black scales gradually widening to extend over entire anterior and ventral surfaces just before apex. Foretibia mainly black-scaled, with white scales posteroventrally; midtibia with black scales anteriorly, white scales posteriorly; hindtibia mainly black-scaled, posteroventral surface with whitish scales, anterior and dorsal surfaces with whitish scales at apex. Tarsi black-scaled, tarsomere 1 of fore- and midlegs with some pale scales on posterior surface. Pulvilli pale. Ungues black; anterior foreunguis larger than posterior foreunguis, posterior foreunguis about 0.75 length of anterior foreunguis, both stout, anterior foreunguis with small ventral tooth near midlength, posterior foreunguis with small tooth nearer base; anterior midunguis like that of foreleg, posterior midunguis shorter and more slender than posterior unguis of foreleg but with tiny ventral tooth near midlength; hindungues very small, simple. *Abdomen* (Fig. 5G): Terga mainly black-scaled; tergum I golden setose, with posteromesal patch of black scales; posterior margins of terga II–VII with row of golden setae, median setae about length of basal band of next tergum, lateral setae longer, about 0.75 of tergum length; lateral scale-free areas of terga II–VII with long, laterally-directed, posteriorly-curved golden setae; tergum II with small basomedian spot

Fig. 5. *Culex (Culex) pipiens* Linnaeus. A, Scutum of alloneotype female. B, Thorax of neotype male (left side). C, Female cibarial armature. D, Female genitalia. E, Legs of neotype male (anterior aspect of left legs). F, Right wing of alloneotype female (dorsal). G, Abdomen of neotype male (dorsal). H, I, Abdomen of alloneotype female (H, dorsal; I, left side). Scales in mm.

of yellowish scales; terga III–VII with basal yellowish bands 0.35 of tergum length, bands of terga V–VII produced posteriorly along lateral scale-free areas, particularly on terga VI and VII; anterior 0.5 of tergum VIII (ventral in position) with yellowish scales, posterior 0.5 with golden-brown setae and indistinct dusky scales, posterior margin without emargination in middle. Sterna II–VII mainly yellowish (scales same color as basal bands of terga), with some median black scales; sternum VIII (dorsal in position) mainly clothed with yellowish scales, with some subtle dark scales in middle; sterna II–VII golden setose, posterior margin of sternum VIII with row of golden setae. *Genitalia* (Fig. 6C–H): Ninth tergal lobes small, each with 12 setae in 2 irregular rows. Gonocoxite normal, ventrolateral setae strongly developed, these longer and stouter than lateral setae, mesal surface with 5 rows of small setae extending from base to level of subapical lobe; subapical lobe undivided, setae *a–f* in more or less straight row with gap between *c* and *d*, seta *g* immediately lateral to *d–f*, seta *h* lateral to *g*; *a–c* slightly curved, *a* stout and rodlike with blunt apex, *b* and *c* each with stout base, tapering distally and with apex hooked and pointed; *d–f* shorter than *a–c*, hooked apically, *d* and *e* slender, *f* laterally flattened and appearing broad in lateral view; *g* foliform, longer than broad, slightly asymmetrical, apex not sharply produced; *h* slender, bent distally. Gonostylus stout, curved, concave dorsal surface with 2 small, slender setae on distal 0.3; gonostylar claw short, broadest apically, troughlike. Phallosome longer than broad with lateral plates and aedeagus of nearly equal length; lateral plate with definite dorsal, lateral, and ventral arms, dorsal arm broad, apex nearly truncate, diverging laterally from its mate of the opposite side, appearing slightly sinuous in lateral view; lateral arm broad in lateral view, its posterior margin more or less trilobed, the ventral lobe more prominent than the others and bent ventrolaterally, base of lateral arm with thumblike dorsal process, base of this process continuous mesally with dorsal aedeagal bridge; ventral arm narrow and sharply curved with apex directed laterally; DV/D –0.03. Aedeagus subcylindrical, narrowed distally; ventral aedeagal bridge relatively wide, joining aedeagal sclerites just beyond midlength. Proctiger without distinctive features; paraproct with small, conical basal lateral arm, crown dark with numerous short, spinelike spicules. Cercal sclerite elongate, somewhat kidney-shaped, caudal margin irregular; 6 and 5 cercal setae on left and right sides, respectively. Tergum X rectangular, adjoining paraproct below and behind basal lateral arm.

Alloneotype: ♀ (1–91) with associated larval and pupal exuviae and same data as neotype.

Female (Alloneotype). Like neotype except as follows. *Head*: Length of antennal flagellum 2.1 mm, entirely dark, pedicel and flagellomere 1 with tiny pale scales on mesal surface. Ventral surface of proboscis with creamy-white scales 0.1 to 0.7 from base. Maxillary palpus entirely black-scaled; length 0.36 mm, about 0.16 of proboscis length. Forked scales of vertex more numerous, more pale scales medially. *Cibarial armature* (Fig. 5C, described and illustrated from specimens collected with the alloneotype): Cibarial crest concave, slightly produced in middle; with about 28 short, blunt teeth. Cibarial dome nearly elliptical in dorsal outline, produced anteriorly in middle; surface largely granular, imbricated posteriorly. *Thorax* (Fig. 5A): Scutal and pleural scales and setae same as neotype except scales and integument between supraalar and posterior dorsocentral setae noticeably darker, forming a pair of ovoid spots, and upper proepisternal scales

more numerous, with small patch of indistinct dusky scales on mesal side of setae; postpronotum with 6 setae and few narrow spatulate scales interspersed with pale falcate scales posteriorly; numbers of pleural setae on left side differ as follows: 8 upper proepisternal, 8 prealar, 8 lower mesokatepisternal, and 9 upper mesepimeral. *Wing* (Fig. 5F): Length 4.3 mm; cell R_2 5.2 of R_{2+3} ; subcosta intersects costa beyond furcation of R_{2+3} ; cell M_1 0.75 of cell R_2 ; remigium of both wings with 2 setae. *Legs*: Like neotype except midcoxa with 5 large and 5 small setae in midlateral row; hindcoxa with 9 setae on posterolateral surface. Pulvilli distinct. Ungues small, simple, black; fore- and midungues stouter than hindungues. *Abdomen* (Fig. 5H, I): Tergum II with basomedian spot of yellowish scales and lateral patches of white scales; terga III–VII with basal bands of yellowish scales and basolateral spots of white scales, spots becoming gradually larger on succeeding posterior terga and actually cover entire lateral surfaces of tergum VII, bands 0.25 of tergum length, slightly convex on terga III and IV and not quite reaching spots, straight on terga V–VII and contiguous with spots, bands of terga VI and VII slightly produced posteriorly along mesal side of spots; tergum VIII clothed with whitish scales. Sterna II–VII like those of neotype; sternum VIII with whitish scales on lateral margins, broad median area without scales. *Genitalia* (Fig. 5D, described and illustrated from specimens collected with the alloneotype): Sternum VIII with rounded median posterior emargination. Tergum IX narrow, posterolateral margin with 6–8 setae. Upper vaginal lip narrow, distinct; 8–11 insular setae in dense cluster immediately anterior to indistinct lower vaginal lip. Upper vaginal sclerite distinct, U-shaped. Postgenital lobe short, apex evenly rounded, with submedian row of 7 setae extending from dorsal to ventral surface over apex. Cercus short, laterally compressed, apex bluntly rounded, lateral and ventral surfaces setose; cercus/dorsal postgenital lobe index about 2.3.

Specimens collected with the neotype and alloneotype exhibited the following variation. *Head*: Proboscis length 2.16–2.26 mm, mean 2.20 mm. Maxillary palpus of female sometimes with some pale scales dorsally on palpomere 4, length 0.36–0.40 mm, mean 0.39 mm; length of palpus in male 2.80–3.00 mm, mean 2.9 mm, often extending beyond tip of proboscis by less than length of palpomere 5. *Thorax*: Ovoid spots of scutum usually moderately distinct in dorsal aspect, usually indistinct in lateral view; acrostichal and fossal scales often as dark as ovoid spots in females. Postpronotum with 5–9 setae, most often with 5. Pleural setae as follows: females with 8–13 and males with 18–25 upper proepisternal; both sexes with 8–12 prealar, 4–7 upper mesokatepisternal, 8–13 lower mesokatepisternal, and 5–12 upper mesepimeral. Prealar area occasionally with few inconspicuous pale scales immediately below setae (present on one side in 5♂ and 5♀ of 108 specimens examined). *Wing*: Length 4.3–4.5 mm in females, 3.4–3.7 mm in males; cell R_2/R_{3+4} 4.9–5.5 in females, 2.6–3.6 in males; cell M_1 /cell R_2 0.72–0.82. *Abdomen*: Basal bands of terga always yellowish, usually 0.25–0.40 of tergum length in males, 0.15–0.35 in females, bands in males usually like those of neotype, bands in females variable as follows: basomedian spot of tergum II often nearly lost, tergum III frequently with convex basomedian spot, bands of terga VI and VII often very narrow, that of VII sometimes absent in middle. Tergum VIII of female with yellowish or whitish scales, scales usually paler than those of basal bands of proceeding terga; sometimes with some dark scales posteriorly in middle. Sterna almost always with dark scales medially, dark scales

sometimes on proximal 0.5 only, sometimes arrayed as speckles, often forming complete stripe; sternum VIII of males (dorsal in position) usually largely pale with dusky scales posteriorly in middle, sometimes entirely pale. *Genitalia* (of male): DV/D zero to -0.19 , mean -0.09 (for 15 specimens).

Pupa (Neotype) (Fig. 6A, B). Character and positions of setae as figured. *Cephalothorax*: Lightly tanned, legs, scutum, metanotum, and metathoracic wings darker. *Trumpet*: Moderately tanned, subcylindrical, gradually widened distally, index 4.9; tracheoid area darker, extending 0.3 from base; pinna oblique, about length of tracheoid area. *Abdomen*: Lightly tanned, terga 1–VI darker in middle; length 2.9 mm. *Genital lobe*: Lightly tanned; length 0.3 mm. *Paddle*: Lightly tanned, midrib and buttress darker; outer margin without distinct spicules; midrib distinct except at apex; length 0.9 mm, width 0.6 mm, index 1.5.

The alloneotype resembles the neotype except as follows: trumpet index 5.4, abdominal length 3.3 mm; genital lobe length 0.2 mm; paddle 1.0×0.7 mm with index 1.4.

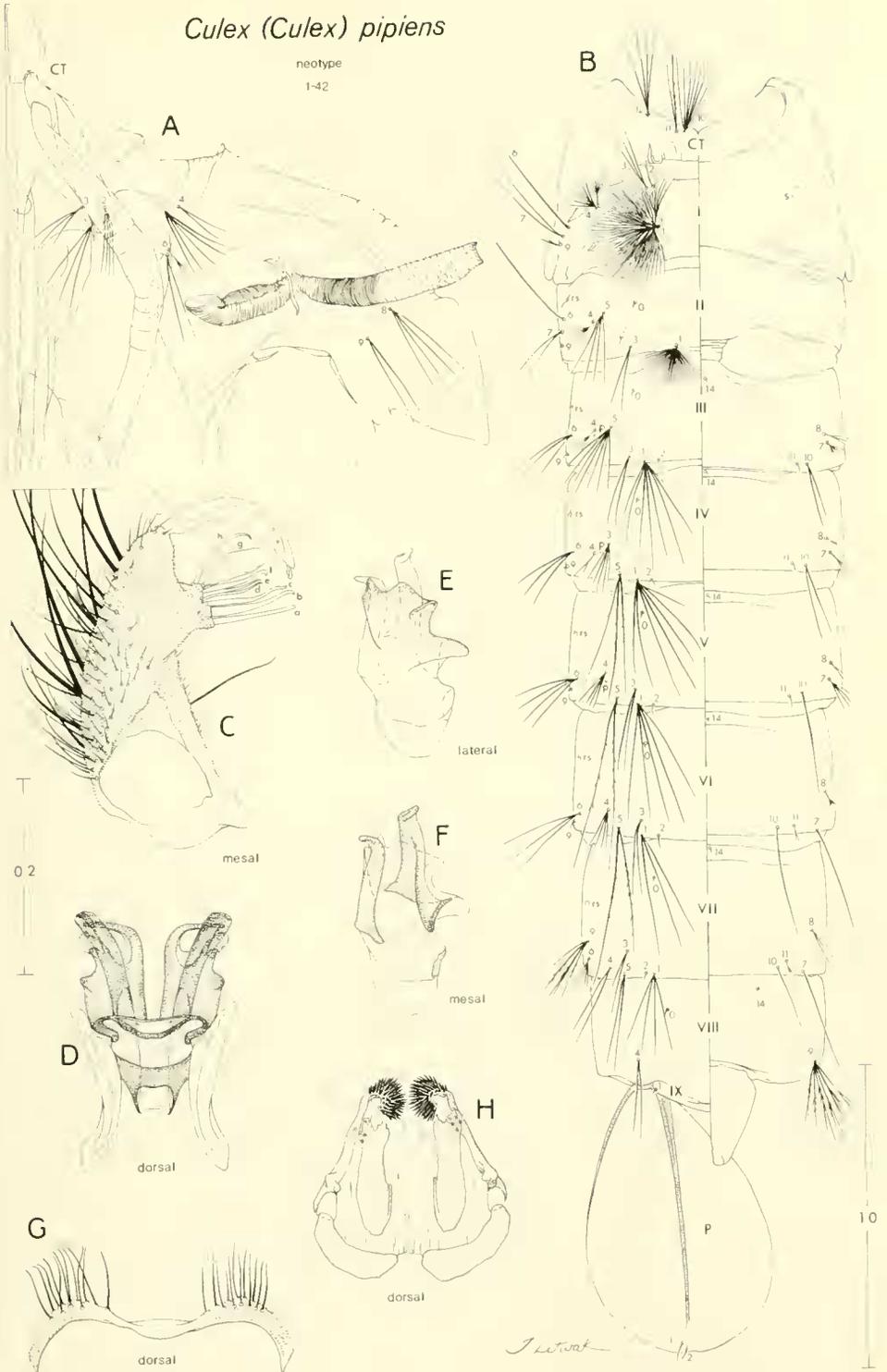
Table 1 lists the range and modal number of branches for pupal setae observed in the neotype, alloneotype, and 10 associated specimens. Diagnostic and variable characters follow. *Cephalothorax*: Setae 1, 2-CT with 3–5 branches; 3, 4-CT with 2 or 3 branches, commonly 3; 5-CT usually with 5 branches (3–6); 6-CT usually with 3 branches (1–4); 7, 9, 11-CT double; 10-CT frequently with 6 branches (6–13); 12-CT usually double (2–4). *Trumpet*: Index 4.8–6.9, mean 5.5. *Abdomen*: Seta 6-I, II single; 7-I, II usually double; 1-II usually with more than 20 branches (15–26); 1-III–V frequently with at least 6 branches, 1-III usually with 8 branches (6–10), 1-IV usually with 6 or more branches (3–8), 1-V most often with 6 branches (4–6); 2-II, VII lateral to seta 1, 2-III–VI mesal to 1; 5-IV usually triple, sometimes with 4 or more branches; 5-V–VII almost always double; 6-III, IV most often with 3 branches, 6-V, VI most often with 4 branches. *Paddle*: Index 1.2–1.6, mean 1.4.

Larva (Neotype) (Fig. 7). Character and placement of setae as figured. *Head*: Wider than long, length 0.7 mm, width 1.0 mm; approximately anterior 0.5 lightly tanned, labiogula, lateralialia posterior to seta 10-C, and dorsal apotome behind seta 5-C moderately tanned. Median labral plate narrow but distinct, anterior margin slightly emarginate between insertions of seta 1-C. Labiogula narrower anteriorly than posteriorly, length about same as posterior width; hypostomal suture complete, extended posterolaterally from posterior tentorial pit to near collar. Collar best developed along lateralialia, heavily tanned. Mouthparts developed for filter-feeding. Dorsomentum with 8 and 9 teeth on left and right sides of median tooth, respectively. *Antenna*: Length 0.5 mm, 0.7 length of head; moderately tanned, mesal surface with dark spot at base; seta 1-A 0.7 from base, part proximal to seta 1-A with strongly-developed aciculae mainly on dorsal and lateral surfaces, distal part slender and smooth except for few short aciculae laterally near seta 1-A. *Thorax*: Integument hyaline, tubercles of all large setae

Fig. 6. *Culex (Culex) pipiens* Linnaeus, neotype male. A, B, Pupa (A, dorsolateral aspect of cephalothorax, left side; B, dorsal and ventral aspects of left side of metathorax and abdomen). C–H, Genitalia, aspects as indicated (C, gonocoxite; D, phallosome; E, F, lateral plate and aedeagal sclerite; G, tergum IX; H, proctiger and terga X). Scales in mm.

Culex (Culex) pipiens

neotype
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moderately tanned; setae 1-3-P and 9-12-P, M, T on common tubercles. *Abdomen*: Integument hyaline, tubercles of setae 7-I, 6-I-VI and 1, 3-VIII moderately tanned, tubercle of setae 2, 3-X heavily tanned. *Segment VIII*: Comb consisting of 40 and 42 scales on left and right sides, respectively; scales short, evenly fringed on sides and apex, arranged in 4 irregular rows. *Siphon*: Index 5.0; subcylindrical, broadest at base, slightly sigmoid in lateral view; moderately tanned, darker at base; acus attached, longer on posterior side of attachment. Pecten on basal 0.3 of siphon, that of left and right sides with 14 and 11 spines, respectively, spines increasing in size from base of siphon, larger spines with 3 long basal denticles. Seta 1-S in 4 pairs, 1a-S very near most distal pecten spine, 1c-S distinctly out of line with others. *Segment X*: Saddle complete; moderately tanned, darker dorsally; posterodorsal area with minute spicules; length 0.3 mm. Ventral brush (seta 4-X) with 6 pairs of setae arising from grid, setae increasing in length posteriorly, most posterior seta 7.5 length of most anterior. Anal papillae elongate, subacutely tapered; dorsal pair longer than ventral pair, dorsal pair twice length of saddle.

The alloneotype resembles the neotype except for minor differences in the number of branches of some setae, and principally as follows: length of head 0.8 mm, width the same; comb with 49 and 52 scales on left and right sides, respectively; siphon index 4.9, pecten with 17 and 16 spines on left and right sides, respectively.

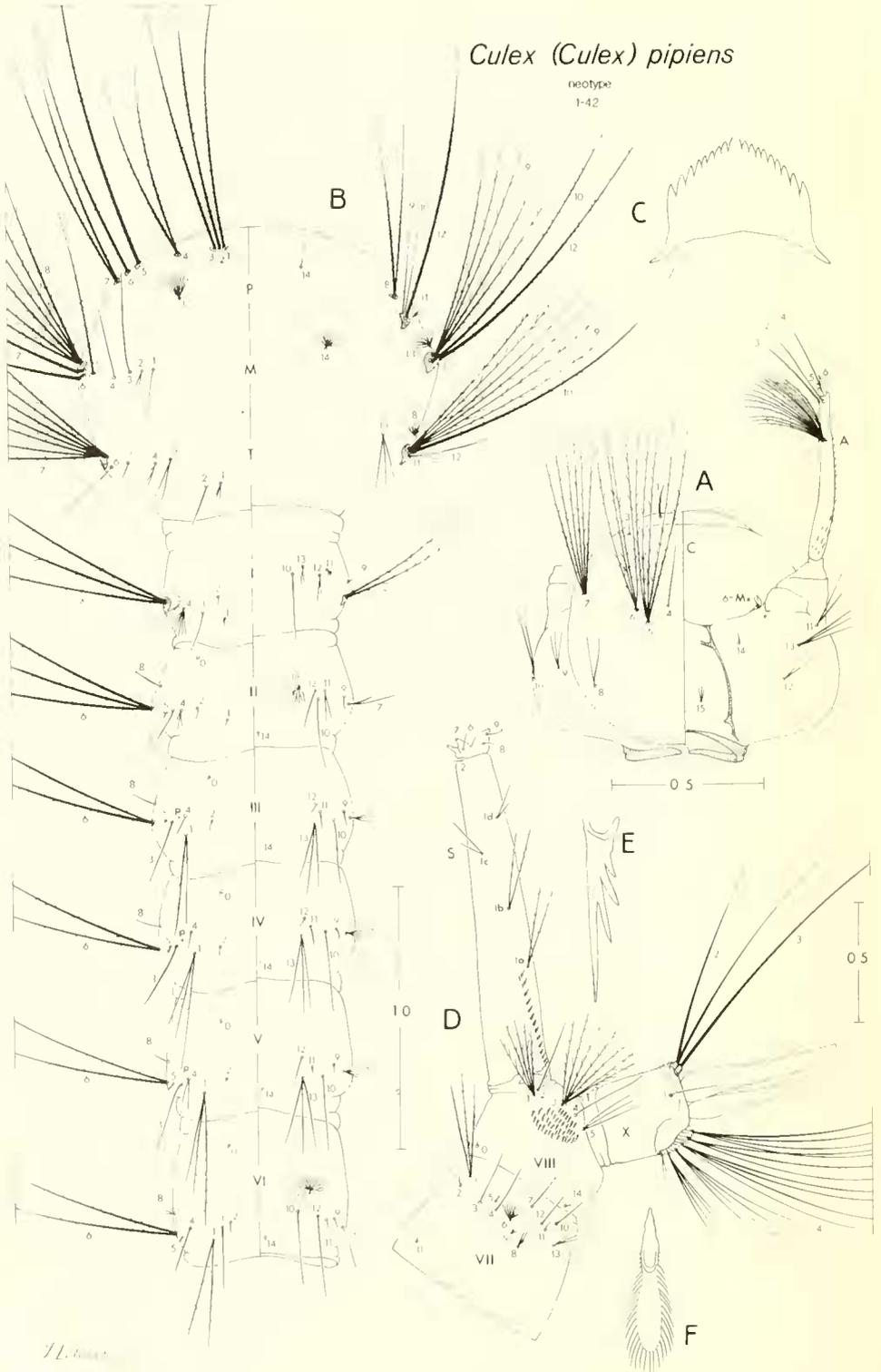
Table 2 lists the range and modal number of branches for larval setae determined from the neotype, alloneotype, and 10 associated specimens. Diagnostic and variable characters include the following. *Head*: Seta 1-C slender, tapered distally, slightly bent mesad; 3-C distinct; 2-C absent; 4-C single, rather long; 5-C frequently with 4 branches (4-6); 6-C most often with 4 branches (3-5); 7-C resembles 5, 6-C, with 6-10 branches; 8, 10-C usually double (2, 3); 11, 12, 13-C double or triple, 13-C occasionally with 4 branches; dorsomentum most often with 10 teeth (8-11) on either side of median tooth. *Thorax*: Setae 1-3-P single, nearly of equal length; 4, 7, 8-P double rarely single; 11-P usually with 4 or 5 branches (3-7). Seta 1-M usually single, occasionally double, about 0.5 length of 3-M; 3-M single; 4-M usually double, occasionally single. Seta 1-T short, 0.5 or less length of 2-T, most often double (1-4); 2-T usually single or double, infrequently with 3 or 4 branches. *Abdomen*: Seta 3-I, VII usually single, sometimes double (3-I double on at least one side in 27 of 112 specimens examined; 3-VII double in only 16); seta 6-I-VI long, 6-I, II usually with 3 branches (2-4), 6-III-VI double; 7-I resembles 6-I, almost always double; 1-III-VI usually double, one branch longer than the other. *Segment VIII*: Comb with 37-57 scales, mean 44; seta 1-VIII most often with 5 branches; 3-VIII frequently with 7 branches; 5-VIII with 3 or 4 branches, more often with 4. *Siphon*: Always slightly S-shaped in lateral view; index 4.5-5.8, mean 5.0; pecten with 11-17 spines, most often with 14; usually with 4 pairs of seta 1-S (in 112 specimens examined, 3 with 3 on one side, 9 with 5 on one side and 2 with 5 on both sides). *Segment X*: Seta 1-X usually single (double on one side in 10, and both sides in 3, of 112 specimens examined); ventral brush (seta 4-X) almost always with 6 pairs of setae.

DISCUSSION

Culex pipiens and *Cx. torrentium* are the only species of *Culex* (*Culex*) known to occur in central and northern Europe. As mentioned earlier, *Cx. torrentium*

Culex (Culex) pipiens

neotype
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was confused with *pipiens* until Martini (1925) recognized it as a separate species. Since these species frequently occur together in the same habitat, it is possible that the figures published by the authors cited by Linnaeus (1758) were based on specimens of either *pipiens* or *torrentium* or both. Nevertheless, the concept of *pipiens* which has been handed down to us is that explicitly defined by Dyar and Knab (1909). This is the species we collected, reared, and selected as the neotype, allonotype, and associated specimens of *Culex pipiens*.

In the adult stage, *Cx. pipiens* is reliably differentiated from *torrentium* by the character of the male genitalia. In *torrentium*, the posterior margin of the lateral plate bears a spiculate lobe and the dorsal arms are pointed. Mattingly (1951) denoted that *torrentium* could be distinguished from *pipiens* by the presence of prealar scales, but this character is not totally reliable (Service, 1968; Jupp, 1979; Onyeka, 1982). Prealar scales are occasionally absent in *torrentium* and sometimes present in *pipiens*. We have noted that specimens of *torrentium* contained in our two collections bear an inconspicuous dorsal pale spot at the apex of the foretibia. The potential diagnostic value of this character needs to be investigated in other populations of *torrentium*.

The larvae of *pipiens* and *torrentium* are similar. Natvig (1948) could not differentiate them and considered all larvae examined from Scandinavia and Finland to be *pipiens*. Sicart (1954) reported that the character of seta 1-X might be useful for separating the larvae of these species. He observed that seta 1-X was single in *pipiens* and double in *torrentium*. Later, Callot (1957) and Doby and Rault (1960) relied on this character to separate *pipiens* and *torrentium* in France. But as Service (1968) discovered, this seta may be single or double in either species, and cannot be used to separate them with confidence. As a matter of course, we examined the larval chaetotaxy of *torrentium* for comparison with that of *pipiens*. In so doing, we found that *torrentium* could usually be separated from *pipiens* by the character of seta 1-T. The length of this seta was normally greater than one-half the length of seta 2-T in *torrentium* and less than one-half in *pipiens*. In cases where this seta was missing, obstructed from view, or its length was questionable, the following combination of characters identified *torrentium*: setae 3-I, VII and 1-X usually double with 3-1 sometimes triple. These setae are usually, but not always, single in *pipiens*. Never were all three setae single in any one specimen of *torrentium* or double in any one specimen of *pipiens*. Seta 3-1 was never triple in *pipiens*.

The taxonomy of the *pipiens* complex is an enigma complicated by interpretational difficulties and controversy associated with a number of bewildering morphological, behavioral/physiological, and genetic issues. An understanding of these issues is intimately related to the resolution of the *pipiens* complex. On the other hand, the delimitation and fixation of the concepts and their names for the taxa involved is fundamental to all taxonomic, morphological, behavioral/physiological, and genetic studies. Neotypes have now been designated for the three

Fig. 7. *Culex (Culex) pipiens* Linnaeus, neotype male, larva. A, Head (dorsal and ventral aspects of left side). B, Thorax and abdominal segments I-VI (dorsal and ventral aspects of left side). C, Dorsosentum. D, Abdominal segments VII-X (left side). E, Pecten spine. F, Comb scale. Scales in mm.

principal nominal forms of the *pipiens* complex: *Culex quinquefasciatus* Say, *Culex molestus* Forskål, and *Culex pipiens* Linnaeus. With this, an important step has been taken toward resolving the taxonomy of this important group of species.

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